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INSTINCT.

By H. L. MILLER, High School, Topeka.

Read before the Academy, at Topeka, December 30, 1904.

NO better subject than instinct could be found to demonstrate that knowledge begins and ends in mystery. The biologist amuses himself in observing the battle waged between the physiologist and the psychologist, the one attributing reactions in lower organisms to mechanical stimuli; the other accepting the indisputable states of consciousness in the higher forms of life; the two approaching each other by traveling in parallel lines. The common-sense view attributes all activities to the nature of the animal. It is only the mind debauched with learning that finds difficulty in explaining common things. The sophomore can write a breezy paper on a subject that would tax to the utmost the mind of a candidate for the doctor's degree. Lack of agreement in terminology affords a wide field for the savant and the neophyte.

The doctrine of "parallelism" seems to be reasonable—"every psychic phenomenon has a determinate physical concomitant." If there could be established an objective criterion of consciousness, there might be some information obtained on animal intelligence. Certainly mental states are conditioned or accompanied by physical states, and there are numerous well-defined physical signs of mental life. But even introspective psychology reaches the point where silence is the highest manifestation of reason. A sensation of red perceived by me has no imaginable community either with vibrations of ether or with physico-chemical modifications of retinal or cerebral cells. My perception of space, surface, volume has no conceivable community of nature with that of objective surface or extent. My perception of five miles will not have anything like extensiveness in consciousness. No distance in perception separates objective realities. The "impassable chasm" is fixed. The law is absolute and fundamental. The metaphysician may have a theory that will satisfy any one but the scientist. The tendency is to get away from any anthropomorphic conception of instincts. The physiological method begins with the lowest forms of life and by a series of experiments through the ascending scale would explain motor manifestations by referring them to physico-chemical mechanisms.

Possibly the realm of consciousness and intelligence is reached somewhere about the dividing line between the invertebrates and the vertebrates. The following experiment is mentioned in introducing

the physiological method: Place a small quantity of acidulated water in a vessel, a bit of mercury, and a crystal of bichromate of potash. In a moment the mercury becomes the seat of little tremors; then it spreads itself around the crystal and dances excitedly. It may withdraw for a short time and then make a fresh attack. The activity ceases when the crystal is dissolved. Here one almost says it exercises choice. The movements appear spontaneous. The resting state that follows the battle seems to be a state of satisfaction.

Doctor Loeb has performed a large number of experiments upon starfish, medusæ, worms, and insects, from which he concludes that so-called instinctive acts are nothing more than mechanical effects of such general forces as light, gravity, etc., acting in common upon plants and animals. When the moth flies into the flame it is not necessary to speak of its love of light; or of danger when the mollusk withdraws into its shell; or of discomfort when the crab is turned on its back; or predilection for the dark when an animal avoids the light; or of intelligent forethought when the fly lays its egg on objects which serve the hatching larvæ as food. The so-called purposeful character of instincts does not distinguish them from reflexes. Nature may say to her fishy children, "Bite at every worm, for there are fewer impaled on hooks than not," and to the fly, "Try the web of the wily spider." Instinct is usually defined as "the faculty of acting in such a way as to produce certain ends without foresight of the ends and without previous education in the performance." The conventional discrimination between reflex and instinctive reaction does not aid us in the understanding of these phenomena, for both are concerned with reactions to external stimuli and conditions. The latter is usually thought of as a chain of reflexes causing the whole organism to react. It may be congenital. An organism replete with motion behaves instinctively, and the nervous system serves as a protoplasmic bridge or conductor from sense organs and muscles.

The results of a few experiments by Loeb will better convey the meaning of these statements. His conception of "tropisms" will explain the reactions in simple organisms and may be applied to some of the more complex reactions of higher animals; at any rate, there is a chance for such inference.

The moth flying in the region of a strong light is drawn into it, not through curiosity nor by attraction. The muscles on the side toward the light are positively heliotropic, and the moth, a symmetrical thing, is turned in a medial line for the light, and, if flying swiftly, has momentum to carry it into the flame. This kind of orientation is familiar to the botanist. The udendrium in its stem relations to the window illustrates the same principle. Simple chem-

ical and mechanical effects on muscles turn the moth into the flame.

The movement is heliotropic. The assumption is that chemical substances are acted upon by the light in such a way as to produce changes of tension in the contractile tissue. Symmetry of form is necessary.

Again, a galvanic current is passed through a medium in which are placed a number of *Palæmonetes*. The movement of these animals is toward the anode. Hence, galvanotropism is the term used to explain the orientation.

Another illustration is that of contact instinct. The crawling of animals into crevices is shown not to be for the purpose of self-preservation, but rather to get the body in solid contact as extensively as possible. No center theory is necessary. A peculiar species of butterfly, *amphipyra*, will run about until it finds a corner or crack into which it can creep. These animals were placed in a box, one-half of which was covered with glass, the other half with a non-transparent body. Small glass plates were placed in the bottom of the box, raised just enough to allow the butterflies to creep under. They collected without any choice of light effects. As soon as their bodies were brought in contact with solid bodies they became quiet, even when exposed to direct sunlight. It is not necessary to look for a center of self-concealment in these animals. The reaction is common to plants. Loeb has given this kind of irritability the name of stereotropism.

It is a wonderful arrangement in nature that in some species the female lays her eggs in places where the larvæ will find just the kind of food they require, decaying meat, cheese, and refuse of animals. The fly lays the eggs on lean meat and not on fat. The larvæ will die if fed on fat meat. Further study of larvæ showed that they are oriented by certain substances which radiate from a center—the center of diffusion. The chemical effects of the diffusing molecules on certain elements of the skin influence tension of muscles. Such orientation is termed chemotropism, and if the organism shows the positive kind it is led to those substances which are capable of furnishing appropriate stimuli. Such substances are the volatile nitrogenous compounds. The eggs are deposited in response to a "tropism" and not in response to experience or volition. The presence in the skin of a substance which is altered by the above-mentioned volatile compounds, together with bilateral symmetry of the animal, explains the reaction.

Caterpillars of *Corthesia* (butterflies) are oriented by the light. Until they have taken food they are positively heliotropic, and this leads them to the tips of the branches, where they find their food; and as soon as they have eaten they crawl downward. The taking of food destroys the substances in the skin which are sensitive to light.

Migrations of certain pelagic animals were observed, and the conclusion was reached as above. Positive and negative heliotropism causes the upward and downward migrations. Geotropism enters into the explanation of periodic depth migrations.

These experiments, given somewhat at length, will be sufficient to show Doctor Loeb's view. The analysis of instincts is purely from a physiological point of view. He rests his case with the belief that ultimately data will be furnished for a scientific ethics. The theory that instincts can be explained on the basis of the physical and chemical qualities of protoplasm may give us a scientific phylogeny. He says that man does not work in the fear of poverty, but from the instinct of workmanship. We are instinctively forced to be active.

Applying this concept of "tropisms" to our activities. I suppose we should say, then, that there is a negative heliotropism among bakers and actresses who turn night into day; and that people are led to the beer-gardens by the bright lights, through a positive heliotropism. And there would be nosotropism for physicians, necrotropism for undertakers, ptyotropism for gardeners, and geotropism for field laborers. Everything depends upon the definition of a tropism, which is growing more complicated than instincts. The action of the organic mechanism is explained by the theory. If we define instinct on the physical basis as in inherited mechanism replete with motion, two problems arise: First, the origin of the mechanism; second, the motion and the stimulus that are contained in the explanation of the action immediately. No one but the cock-sure evolutionist would attempt to account for the former. Toward the explanation of the latter it seems to me Doctor Loeb has made a valuable contribution. The mechanism is an arrangement of nervous tissue, or possibly in some cases muscular tissue such that the energy which it contains finds a way of discharge that is generally regular and determinate. Individual experience must be considered in determinate actions, however. When the precise organization is inherited then the in-varying action is instinctive, as we understand that term; while if acquired during the lifetime of the individual the action is said to be automatic or reflex. Natural selection may explain a vast number of the higher human instincts, such as self-preservation, honesty, fear, love, socialization, and many others enumerated by James.

But it would seem in the process of adaptation that the larvæ, flies and all, would have perished before the instinct or tropism was planted. But this is the query of a boy, and the satisfaction is in the asking, not in the answer that might be given.

Millions of birds migrate together. The nesting habits are essentially alike. Do they all respond to a climatic stimulus at the same

instant, and is there some chemical or physical contact with objects out of which materials are selected for nests?

The spider without previous instruction spins a web of mechanical perfection, scaffolding for the structure, weaving the geometrical figure with mathematical exactness, taking up the groundwork, and if disturbed the whole process is repeated.

The cooperative incubating industry existing among the brush turkeys of Australia (*Megapodes*) is even more wonderful. Contrary to maternal instinct, these birds gather a great heap of earth and leaves, sometimes fifteen feet high, in which they lay their eggs, and leave them to be hatched by the heat produced by the fermentation and decay of the vegetable matter. The young shift for themselves at once, and may never come in contact with the mother bird. It might be, though it sounds like a fairy tale, that a fortuitous heap was made as a result of the scraping propensity evidenced by the very large shanks of this bird, and, by another fortuitous coincidence, the eggs were left in the said heap and hatched, sending forth a brood congenitally prepared to establish this custom, so that the drudgery of sitting for days on those uninteresting, never-to-be-too-much-sat-upon objects might be foregone.

To all these and a thousand more, given by Mr. Morgan and others, we must say, when asked why and wherefore, *ignorabimus*.

Doctor Loeb has made a valuable contribution in the explanation of reactions in unicellular organisms. How far this theory can be extended with reference to more complex organisms remains for future investigation.